
AP[®] Chemistry

Sample Student Responses and Scoring Commentary

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Free-Response Question 4

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Question 4: Short Answer

4 points

A For the correct answer:

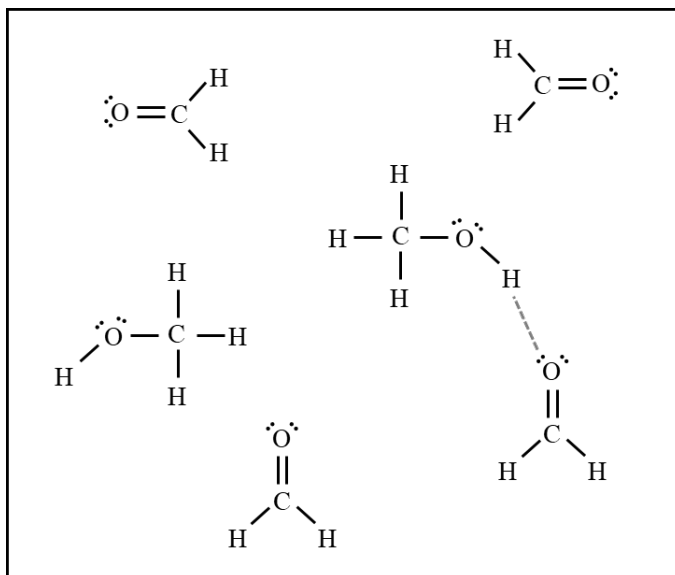
Point 01

 sp^2

B For a correct diagram:

Point 02

The diagram should show a dashed line between the O atom in one H_2CO molecule and the H atom in the $-\text{OH}$ group of one CH_3OH molecule. See example response below.



C (i) For a correct proposal:

Point 03

The proposed temperature should be in the range 181 K–254 K.

(ii) For the correct calculated value:

Point 04

$$8.59 \text{ g CH}_3\text{OH} \times \frac{1 \text{ mol CH}_3\text{OH}}{32.04 \text{ g CH}_3\text{OH}} \times \frac{-37.6 \text{ kJ}}{1 \text{ mol CH}_3\text{OH}} = -10.1 \text{ kJ, so 10.1 kJ are removed.}$$

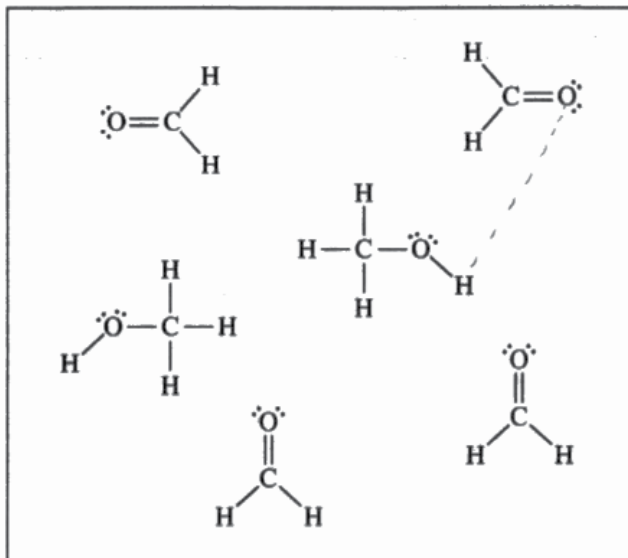
Use a pencil or a pen with black or dark blue ink. Do NOT write your name. Do NOT write outside the box.

Part A

sp²

Question 4

Part B



Part C

i) AT 215 K both substances will both be liquids

$$ii) 8.59 \text{ g CH}_3\text{OH} \times \frac{1 \text{ mol CH}_3\text{OH}}{32.04 \text{ g CH}_3\text{OH}} = 0.268 \text{ mol CH}_3\text{OH}$$

$$0.268 \text{ mol CH}_3\text{OH} \times \frac{37.6 \text{ kJ}}{1 \text{ mol CH}_3\text{OH}} = 10.1 \text{ kJ CH}_3\text{OH removed}$$

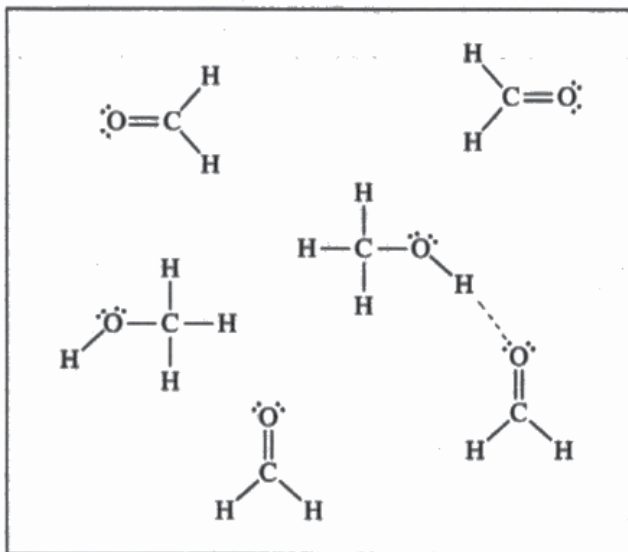
Use a pencil or a pen with black or dark blue ink. Do NOT write your name. Do NOT write outside the box.

Part A

Question 4

sp^3

Part B



Part C

i) 185 K

ii) $q = mC\Delta T$

$$q = (8.59 \text{ g})(338)(4.18 \text{ J/g}\cdot\text{C})$$

$$q = \frac{12136.29 \text{ J}}{1000 \text{ J}} = 12.14 \text{ kJ}$$

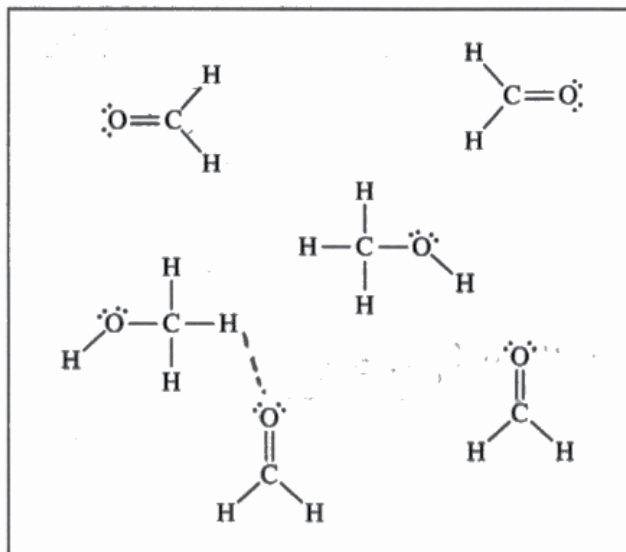
Use a pencil or a pen with black or dark blue ink. Do NOT write your name. Do NOT write outside the box.

Part A

Question 4

sp^2

Part B



Part C

i. 120°K

ii. $8.59\text{g} \times \frac{1\text{mol}}{37.04} \hat{=} .268\text{mol} \times \frac{1.5}{37.6} = .0075$

Question 4

Note: Student samples are quoted verbatim and may contain spelling and grammatical errors.

Overview

NEW for 2025: The question overviews can be found in the *Chief Reader Report on Student Responses on AP Central*.

Sample: 4A

Score: 4

Point 01: 1

Part A: The point was earned for correctly identifying that the carbon has sp^2 hybridization.

Point 02: 1

Part B: The point was earned. While the response does not use the closest potential interaction, it correctly identifies the H covalently bonded to the O in a CH_3OH molecule and draws a dashed line from that H to the O of H_2CO . The bond between the O and H within CH_3OH would have a sufficiently large bond dipole to form the intermolecular attraction with the O in the H_2CO molecule.

Point 03: 1

Part C (i): The point was earned for recognizing that at 215 K the mixture is between the melting and boiling points of both CH_3OH and H_2CO , so both will be liquids.

Point 04: 1

Part C (ii): The point was earned for correctly calculating the number of moles of CH_3OH present and subsequently calculating the kilojoules of energy transferred in the condensation. The response correctly indicates that the energy was removed.

Sample: 4B

Score: 2

Point 01: 0

Part A: The point was not earned. The response incorrectly identifies the carbon in H_2CO as having sp^3 hybridization, which would require four electron domains rather than three domains.

Point 02: 1

Part B: The point was earned for correctly identifying an H covalently bonded to the O in a CH_3OH molecule and drawing a dashed line from that H to the O of H_2CO . The bond between the O and H within CH_3OH would have a sufficiently large bond dipole to form the intermolecular attraction with the O in the H_2CO molecule.

Point 03: 1

Part C (i): The point was earned for recognizing that at 185 K, the temperature of the mixture is between the melting and boiling points of both CH_3OH and H_2CO , so both will be liquids.

Question 4 (continued)**Point 04: 0**

Part C (ii): The point was not earned. The response incorrectly calculates the kilojoules of energy transferred in the condensation by using $q = mc\Delta T$ and substituting the boiling point for the change in temperature and water's specific heat capacity for c . The application of $q = mc\Delta T$ requires a temperature change, which does not happen at the boiling point.

Sample: 4C**Score: 1****Point 01: 1**

Part A: The point was earned for correctly identifying that the carbon in H_2CO has sp^2 hybridization.

Point 02: 0

Part B: The point was not earned. The bond between the C and H within CH_3OH would not have a sufficiently large dipole to form a hydrogen bonding attraction with the O in the H_2CO molecule.

Point 03: 0

Part C (i): The point was not earned. At 120 K, the temperature of the mixture is below the melting points of both CH_3OH and H_2CO , and so both substances will be solids rather than liquids. The response also incorrectly uses a degree symbol for kelvins.

Point 04: 0

Part C (ii): The point was not earned. While the number of moles of CH_3OH present is correctly calculated, the energy transferred in the condensation is incorrectly calculated by dividing, rather than multiplying, by the enthalpy of vaporization.